U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

6.5.1 ESF ATMOSPHERE CLEANUP SYSTEMS

REVIEW RESPONSIBILITIES

Primary - Effluent Treatment Systems Branch (ETSB)

Secondary - None

I. AREAS OF REVIEW

At the construction permit (CP) stage of review, ETSB reviews the information in the applicant's safety analysis report (SAR) in the areas listed below. At the operating license (OL) stage, the ETSB review consists of confirming the design accepted at the CP stage and evaluating the adequacy of the applicant's technical specifications in these areas. The specific ETSB review areas are as follows:

1. The engineered safety feature (ESF) atmosphere cleanup systems designed for fission product removal in post-accident environments. These generally include primary systems, such as in-containment recirculation, and secondary systems, such as standby gas treatment systems and emergency or post accident air cleaning systems for the fuel handling building, control room, shield building and areas containing engineered safety feature components.

2. The system design, design objectives and design criteria. The ETSB reviews the methods of operation and the factors that could influence the filtration capabilities of the system, e.g., system interfaces and potential bypass routes. The components included in each atmospheric cleanup system and the seismic design category of each system are reviewed. Redundancy of the atmosphere cleanup systems, the physical separation of the redundant trains, and the volumetric air flow rate of each train are reviewed.

3. The environmental design criteria, the design pressure and pressure differential, relative humidity, maximum and minimum temperature, and radiation source term.

4. The component design criteria, qualification requirements, and qualification testing of heaters, demisters, prefilters, and high-efficiency particulate air (HEPA) filters, design requirements of the filter and adsorber mounting

frames, system filter and adsorber housings, and water drains, the adsorbent used for removal of gaseous iodines (in the preliminary safety analysis report, PSAR), the physical properties of the adsorbent and the design of the adsorber section of the filter trains (in the final safety analysis report, FSAR). Provisions to inhibit offdesign temperatures in the adsorber section and the design criteria of the system fans or blowers, ductwork, and nousings are also reviewed.

5. Design provisions incorporated in the equipment and features to facilitate operation and maintenance. The design of doors to the filter housings, the spacing of components, alignment and support of filter elements, the spacing of filter elements in the same bank, design of test probes, and provisions for adequate lighting in the filter housing are also reviewed.

6. The design criteria for inplace testing of the air flow distribution to the HEPA filters, dioctyl phthalate (DOP) testing of the HEPA filter sections, and gaseous halogenated hydrocarbon refrigerant bypass leak testing of the activated carbon adsorber section.

7. The laboratory test criteria for the activated carbon adsorbent, qualification and batch tests, provisions for obtaining representative adsorbent samples for laboratory testing in order to estimate the amount of penetration of the system adsorbent throughout its service life (PSAR), and the provisions and conditions for each field and laboratory test (FSAR).

The review of the ESF atmosphere cleanup systems involves review evaluations performed by other branches. The conclusion from their evaluations are used to complete the overall evaluation of the facility. ETSB will coordinate other branches' evaluations that interface with the overall review of the system as follows: the Structural Engineering Branch (SEB) determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), probable maximum flood (PMF), and tornado missiles as part of its primary review responsibility for SRP Sections 3.3.1, 3.3.2, 3.5.3, 3.7.1 through 3.7.4, 3.8.4 and 3.8.5. The Mechanical Engineering Branch (MEB) determines the acceptability of the seismic and quality group classifications for system components as part of its primary review responsibility for SRP Sections 3.2.1 and 3.2.2. The reviews for Technical Specifications and Quality Assurance are coordinated and performed by the Licensing Guidance Branch and the Quality Assurance Branch (QAB) as part of their primary review responsibility for SRP Sections 16.0 and 17.0, respectively. The Instrumentation and Control Systems Branch (ICSB) and Power Systems Branch (PSB) reviews the associated instrumentation including the power supply and electrical distribution systems as part of their primary review responsibility for SRP Sections 7.3, 7.5, and 8.2. The Accident Evaluation Branch (AEB) calculates the doses that could result as a consequence of postulated accidents as part of its primary review responsibility for SRP Sections 6.4, 6.5.2 through 6.5.4, 15.1.5, 15.4.8, 15.4.9, 15.6.2 through 15.6.5, 15.7.4, 15.7.5, and 15.8. Upon request, AEB will calculate filter loadings of all the iodine isotopes under accident conditions to enable ETSB to complete its overall evaluation of the ESF atmosphere cleanup systems. The Equipment Qualification Branch (EQB) reviews the qualification of essential

power or electrical control cables associated with the ESF atmosphere cleanup system as part of its primary responsibility for SRP Section 3.11.

For those areas of review identified above as being reviewed as part of the primary review responsibility of other branches, the acceptance criteria necessary for the review and their methods of application are contained in the referenced SRP section of the corresponding primary branch.

II. ACCEPTANCE CRITERIA

The installed ESF atmosphere cleanup system is needed to mitigate the consequences of postulated accidents by removing from the atmosphere radioactive material that may be released in the event of an accident. ETSB acceptance criteria for the ESF atmosphere cleanup systems are based on meeting the relevant requirements of the following regulations:

A. General Design Criterion 19 as it relates to systems being designed for habitability of the control room under accident and LOCA conditions.

B. General Design Criterion 41 as it relates to the design of systems to be used for containment atmosphere cleanup following postulated accidents, and to control releases to the environment.

C. General Design Criterion 42 and General Design Criterion 43 as they relate to the inspection and testing of containment ESF atmosphere cleanup systems.

D. General Design Criterion 61 as it relates to the design of systems for radioactivity control under normal and postulated accident conditions.

E. General Design Criterion 64 as it relates to monitoring radioactive releases under normal, anticipated operational occurrences and postulated accident conditions from ESF atmosphere cleanup systems.

Relevant requirements of the Commission's Regulations identified above are met by using the regulatory positions contained in Regulatory Guide 1.52 as it relates to the design testing and maintenance of ESF atmosphere cleanup system air filtration and adsorption units.

Specific criteria necessary to meet the relevant requirements of the Commission's regulations are as follows:

The ESF atmosphere cleanup systems should be designed so that they can operate after a design basis accident (DBA) and can retain radioactive material after a DBA. The system should have provisions to prefilter air, remove moisture and meet the Regulatory Guide 1.52 requirements for charcoal adsorption. The systems should be redundant, be designed to Seismic Category I requirements, be able to actuate automatically, and be limited to an air flow rate of approximately 30,000 cfm.

Design of instrumentation for ESF atmosphere cleanup systems should conform to the guidelines of Regulatory Guide 1.52 and to the recommendations of ANSI N509. Minimum instrumentation, readout, recording, and alarm provisions for ESF atmosphere cleanup systems are given in Table 6.5.1-1 of this SRP section.

Environmental design guidelines for acceptability are based on the conditions following a DBA. Radiation source terms should be consistent with the guidelines in Regulatory Guides 1.3, 1.4, 1.7, and 1.25 (Ref. 1, 2, 3, and 4).

Components such as demisters, heaters, prefilters, HEPA filters, mounting frames, filter housings, adsorbent, fans, ductwork and dampers should be designed, constructed and tested in accordance with ANSI 509-1980 design and qualification testing criteria. Water drain design and the accessibility of components and ease of maintenance should be in accordance with the recommendations of ERDA 76-21 (Ref. 8) and ANSI 509 (1980).

Acceptability with respect to inplace testing should include meeting the requirements of ANSI N510-1980 (Ref. 7). For laboratory testing of activated carbon adsorbent, conformance with ANSI N509-1980 will be used as an acceptability criterion.

ETSB will accept the following deviations from the above acceptance criteria for the post loss-of-coolant accident (LOCA) ESF atmosphere cleanup system:

1. If the calculated dose (sum of the long-term doses from the LOCA and the purge dose at the low population zone outer boundary) is less than the guidelines of 10 CFR Part 100, no filtration system is required.

2. If a radioiodine decontamination factor of 10 or less is needed for the calculated dose to be below Part 100, an atmosphere cleanup system that meets the acceptance criteria listed in Item 5 of Acceptance Criteria in SRP Section 11.3 is acceptable.

3. If a radioiodine decontamination factor of greater than 10 is needed for the calculated dose to be below Part 100, the ESF atmosphere cleanup system meeting all of the above acceptance criteria with the exception of Items 2b and 2c of Part C of Regulatory Guide 1.52, is acceptable.

III. REVIEW PROCEDURES

The reviewer will select and emphasize material from this SRP section, as may be appropriate for a particular case.

1. In the ETSB review the plant design is reviewed to determine where ESF atmosphere cleanup systems are needed. This effort is coordinated with AEB.

2. The ETSB review is carried out by making a detailed comparison of atmosphere cleanup system designs with the acceptance criteria of Section II, above. The capability of a system to remove fission products from the atmosphere after a DBA is reviewed, based on a design loading of 2.5 mg of total iodine (radioactive plus stable) per gram of activated charcoal adsorbent. Designs consistent with General Design Criteria 19, 41, 42, 43, 61 and 64, and the guidelines of Regulatory Guide 1.52 will be assigned the system efficiencies for removal of elemental iodine and organic iodides given in Table 2 of Regulatory Guide 1.52 and a system efficiency of 99% for removal of particulates resulting from a DBA. The assigned efficiencies are for AEB use in accident analyses to calculate offsite doses to the whole body and thyroid.

TABLE 6.5.1-1 Minimum instrumentation, readout, recording and alarm provisions for ESF atmosphere cleanup systems

References: ANSI N509 and Regulatory Guide 1.52

Sensing location	Local readout/alarm	Continuously manned control panel (main control room or auxiliary control panel if manning is a tech spec requirement)
Unit inlet or outlet	Flow rate (indication)	Flow rate (recorded indication, high alarm and low alarm signals)
Demister	Pressure Drop (indication) (optional high alarm signal)	
Electric heater	Status indication	
Space between heater and prefilter	Temperature (indication, high alarm and low alarm signals)	Temperature (indication, high alarm, low alarm, trip alarm signals)
Prefilter	Pressure drop (indication, high alarm signal)	
First HEPA (Pre-HEPA)	Pressure drop (indication, high alarm signal)	Pressure drop (recorded indication)
Space between Adsorber and second HEPA (Post-HEPA)	Temperature (two stage high alarm signal)	Temperature (indication, two-stage high alarm signal)
Second HEPA (Post-HEPA)	Pressure drop (indication, high alarm signal)	
Fan	(Optional hand switch and status indication)	Hand switch, status indication
Valve/damper operator	(Optional status indication)	Status indication
Deluge valves	Hand switch, status indication	Hand switch, status indication
System inlet to outlet		Summation of pressure drop across total system, high alarm signal

IV. EVALUATION FINDINGS

ETSB verifies that sufficient information has been provided and that the review is adequate to support conclusions of the following type, to be included in the staff's safety evaluation report:

> The staff concludes that the design of the ESF atmosphere cleanup systems including the equipment and instrumentation to control the release of radioactive materials in gaseous effluents following a postulated design basis accident are acceptable. This conclusion is based on the applicant having met the requirements of General Design Criteria 19, 41, and 61 by providing ESF atmosphere cleanup systems on the control room habitability, containment and associated systems. The applicant has met the requirements of General Design Criteria 41, 43 and 64 by providing a program for inspecting and testing the ESF atmosphere cleanup systems and monitoring for radioactive materials in effluents from these systems. In meeting these regulations the applicant has provided an evaluation that demonstrates that the design of the ESF atmosphere cleanup systems meets the guidelines of Regulatory Guide 1.52 and the ANSI N509 and N510 (Ref's. 6 and7) industry standard. We have reviewed the applicant's system descriptions and design criteria for the ESF atmosphere cleanup systems. Based on our evaluation, we find the proposed ESF atmosphere cleanup systems are acceptable, and the filter efficiencies given in Table 2 of Regulatory Guide 1.52 are appropriate for use in accident analyses.

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides.

VI. REFERENCES

1. Regulatory Guide 1.3, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Boiling Water Reactors."

2. Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Pressurized Water Reactors."

3. Regulatory Guide 1.7, "Control of Combustible Gas Concentrations in Containment Following a Loss-of-Coolant Accident."

4. Regulatory Guide 1.25, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors."

5. Regulatory Guide 1.52, "Design, Testing, and Maintenance Criteria for Post Accident Engineering-Safety-Feature Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants."

6. ANSI N509, "Nuclear Power Plant Air Cleaning Units and Components," American National Standards Institute (1980).

7. ANSI N510, "Testing of Nuclear Air Cleaning Systems," American National Standards Institute (1980).

8. ERDA 76-21, "Nuclear Air Cleaning Handbook," Oak Ridge National Laboratory, C. A. Burchsted, I. E. Kahn and A. B. Fuller, March 31, 1976.

9. "Building Materials List," Underwriters' Laboratories, Inc.

10. 10 CFR Part 50, Appendix A, General Design Criterion 19, "Control Room," Criterion 41, "Containment Atmosphere Cleanup," Criterion 42, "Inspection of Containment Atmosphere Cleanup Systems," Criterion 43, "Testing of Containment Atmosphere Cleanup Systems," Criterion 61, "Fuel Storage and Handling and Radioactivity Control," and Criterion 64, "Monitoring Radioactivity Releases."